

What is claimed is:

1. A neutral beam processing apparatus comprising:

an ion source;

5 an ion pulling-out electrode for pulling out ions from said ion source and generating an ion beam;

a neutralization cell for neutralizing and converting said ion beam pulled out by said ion pulling-out electrode in atmosphere of a neutral gas to a neutral beam;

10 charged particle separating means for separating charged particles from said neutral beam in said neutralization cell and allowing a neutral beam to pass; and

15 a process cell disposed adjacent to said neutralization cell, for housing an object to be processed on a propagation path of said neutral beam passed through said charged particle separating means,

wherein said charged particle separating means includes a multi-aperture electrode having a plurality of apertures through which said neutral beam passes, and a plurality of lines of magnets dispersively disposed adjacent to the multi-aperture electrode, for generating a multi-pole magnetic field near said
25 multi-aperture electrode.

2. A neutral beam processing apparatus comprising:

an ion source;

an ion pulling-out electrode for pulling out ions
from the ion source and generating an ion beam;

5 a neutralization cell for neutralizing and
converting the ion beam pulled out by the ion pulling-
out electrode in atmosphere of a neutral gas to a
neutral beam;

charged particle separating means for separating
10 charged particles from the neutral beam in the
neutralization cell and allowing a neutral beam to
pass; and

a process cell disposed adjacent to said
neutralization cell, for housing an object to be
15 processed on a propagation path of the neutral beam
passed through said charged particle separating means,

wherein said charged particle separating means
includes a multi-aperture electrode to which a
positive potential with respect to a neutralization
20 cell wall defining said neutralization cell is applied
and which has a plurality of apertures through which
said neutral beam passes, a plurality of lines of
magnets dispersively disposed adjacent to the multi-
aperture electrode, for generating a multi-pole
25 magnetic field near said multi-aperture electrode, and

a conductive member which is disposed in a magnetic pole portion of said multi-pole magnetic field in said neutralization cell and to which a negative potential with respect to said multi-aperture electrode is applied.

3. A neutral beam processing apparatus according to claim 2, wherein said plurality of magnet lines also serve as said conductive member.

4. A neutral beam processing apparatus according to claim 2, wherein said plurality of magnet lines are disposed so as to face said conductive member over said multi-aperture electrode.

5. A neutral beam processing apparatus according to any one of claims 2, 3, and 4, further comprising potential difference adjusting means for making a potential difference between a neutralization cell wall defining said neutralization cell and said conductive member.

6. A neutral beam processing apparatus according to any one of claims 1 to 5, further comprising electron replenishing means for supplying or generating

electrons in said neutralization cell.

7. A neutral beam processing apparatus comprising:

an ion source;

5 an ion pulling-out electrode for pulling out ions from said ion source and generating an ion beam;

a neutralization cell for neutralizing and converting said ion beam pulled out by said ion pulling-out electrode in atmosphere of a neutral gas
10 to a neutral beam;

charged particle separating means for separating charged particles from said neutral beam in said neutralization cell and allowing a neutral beam to pass; and

15 a process cell disposed adjacent to said neutralization cell, for housing an object to be processed on a propagation path of said neutral beam passed through said charged particle separating means,

wherein, to a process cell wall for defining said
20 process cell, a mean for giving a negative potential to a plasma generation cell wall for defining said ion source is provided, and to said plasma generation cell wall, a mean for giving a negative potential to a neutralization cell wall for defining said
25 neutralization cell is provided.

8. A neutral beam processing method comprising the steps of:

pulling out ions from an ion source to generate an ion beam;

5 converting the ion beam into a neutral beam in a neutralization cell;

separating and removing ions from charged particles existing in said neutral beam by disposing a multi-aperture electrode on an outlet side of said
10 neutralization cell and by setting a predetermined potential;

generating a multi-pole magnetic field around said multi-aperture electrode by disposing a plurality of magnets near said multi-aperture electrode;

15 separating and removing electrons from charged particles existing in said neutral beam by the multi-pole magnetic field; and

irradiating an object to be processed in a process cell with the neutral beam passed through said multi-
20 aperture electrode.

9. A neutral beam processing method comprising the steps of:

pulling out ions from an ion source and

25 introducing the ions as an ion beam into a

neutralization cell;

generating a multi-pole magnetic field around a multi-aperture electrode to which a positive potential with respect to a neutralization cell wall defining said neutralization cell is applied by disposing the multi-aperture electrode on an outlet side of said neutralization cell and disposing a plurality of magnets near said multi-aperture electrode;

converting said ion beam into a neutral beam in a space potential area which is flat in a wide range in said neutralization cell and is formed by disposing a conductive member to which a negative potential with respect to said multi-aperture electrode is applied in a magnetic pole portion of said multi-pole magnetic field in said neutralization cell;

separating and removing ions from charged particles existing in said neutral beam by said multi-aperture electrode;

separating and removing electrons from the charged particles by said multi-pole magnetic field; and

irradiating an object to be processed in a process cell with the neutral beam passed through said multi-aperture electrode.

10. A neutral beam processing method comprising the steps of:

pulling out ions from an ion source and
introducing the ions as an ion beam into a
5 neutralization cell;

converting said ion beam into a neutral beam in a
neutralization cell;

removing charged particles from said neutral beam
by a charged particle removing means; and

10 irradiating an object to be processed in a process
cell with said neutral beam passed through said
charged particle removing means,

wherein, to a process cell wall for defining said
process cell, giving a negative potential to a plasma
15 generation cell wall for defining said ion source, and
further giving a negative potential to a
neutralization cell wall for defining said neutral
cell, thereby said ion beam pulled-out from said ion
source is prevented from reaching to said process cell.